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Shinozaki

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(54) **DEVELOPER SUPPLY DEVICE AND IMAGE FORMING APPARATUS**

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G03G 15/08 (2006.01)

(52) **U.S. Cl.**
CPC ***G03G 15/0867*** (2013.01); ***G03G 15/0889*** (2013.01); *G03G 2215/066* (2013.01)

(58) **Field of Classification Search**
CPC G03G 15/0867; G03G 15/0889; G03G 2215/066
See application file for complete search history.

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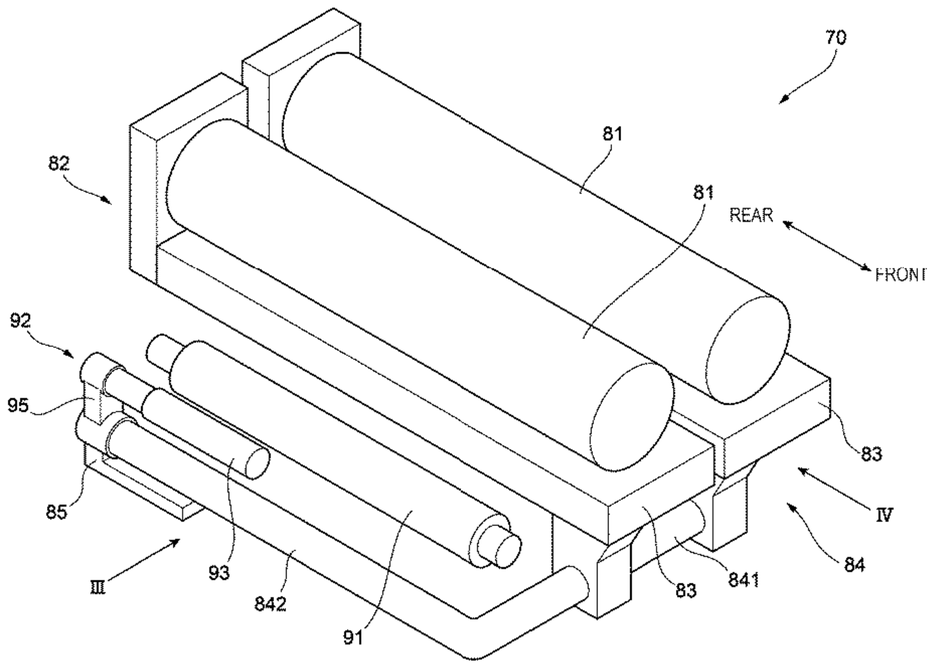
(57) **ABSTRACT**

A developer supply device includes: a toner storage part that can be attached to/removed from a body of the developer supply device and stores toner therein; a toner supply part that receives the toner from the toner storage part and supplies the toner to a developing device that develops an electrostatic latent image formed on an image carrier with developer containing the toner and carrier; a carrier storage part that can be attached to/removed from the body and stores the carrier therein; and a carrier supply part that receives the carrier from the carrier storage part and supplies the carrier to the developing device, the carrier supply part having a smaller capacity than the toner supply part.

12 Claims, 7 Drawing Sheets



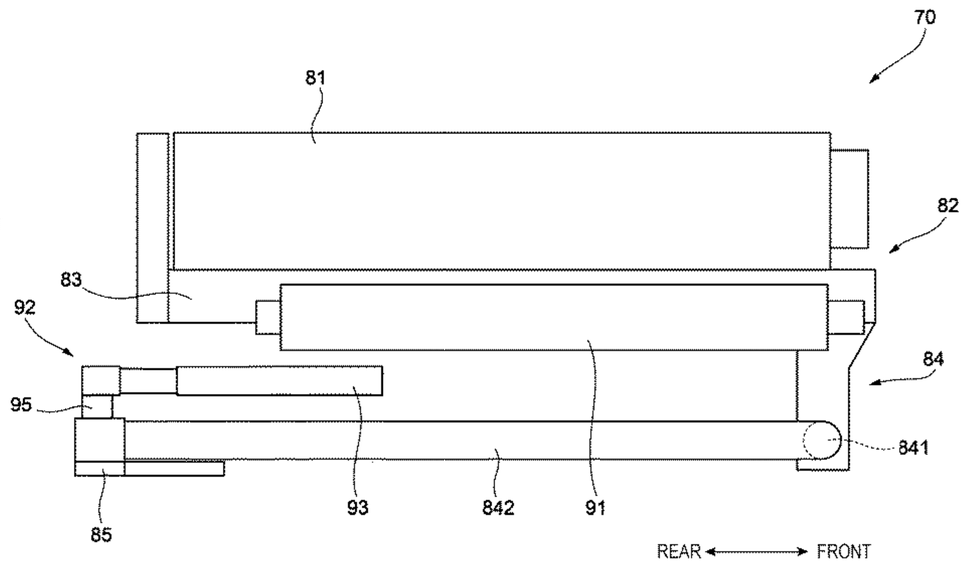
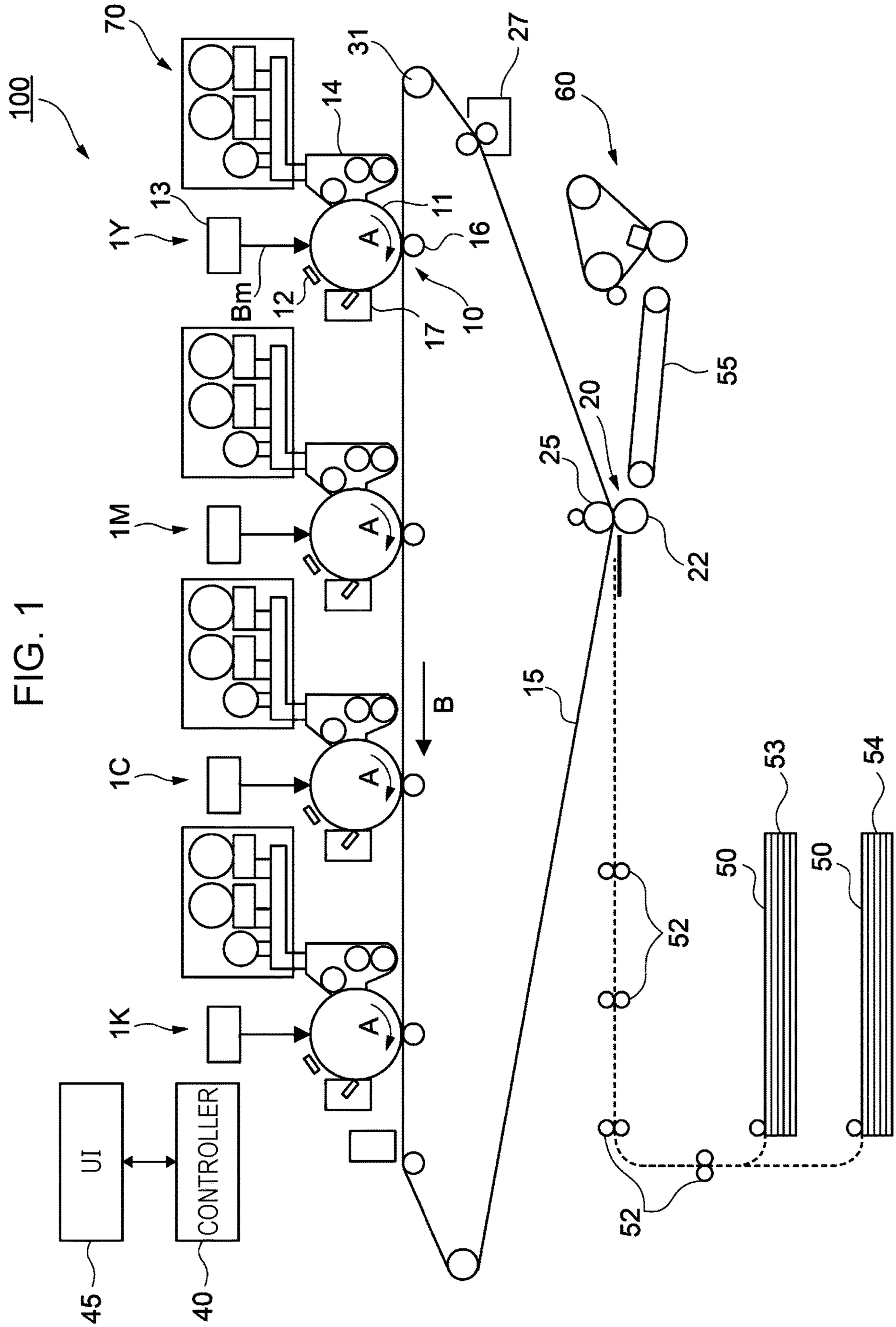


FIG. 1


100
70
31
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Bm
12
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55
22
15
50
53
54
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UI
CONTROLLER
45
40

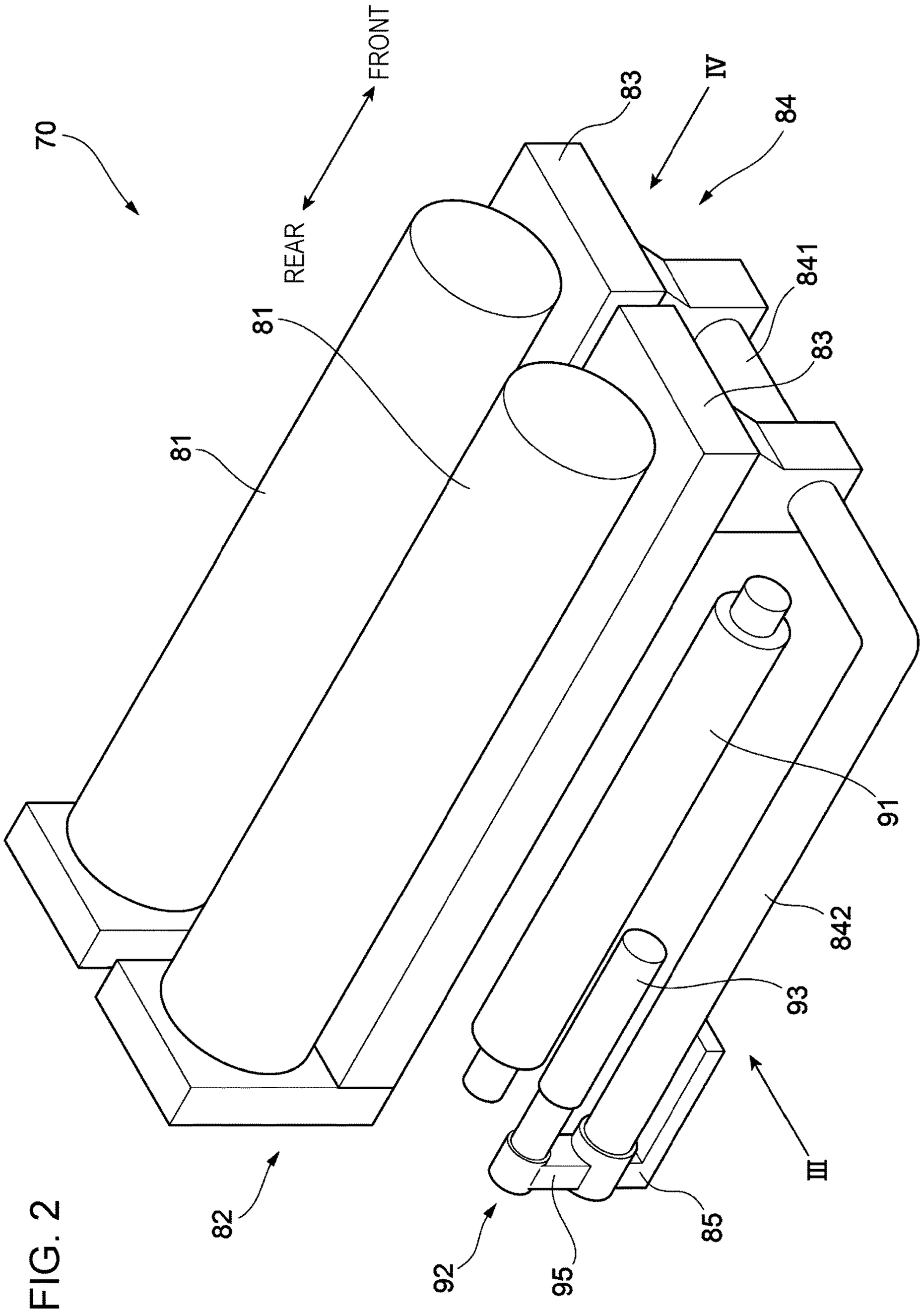


FIG. 2

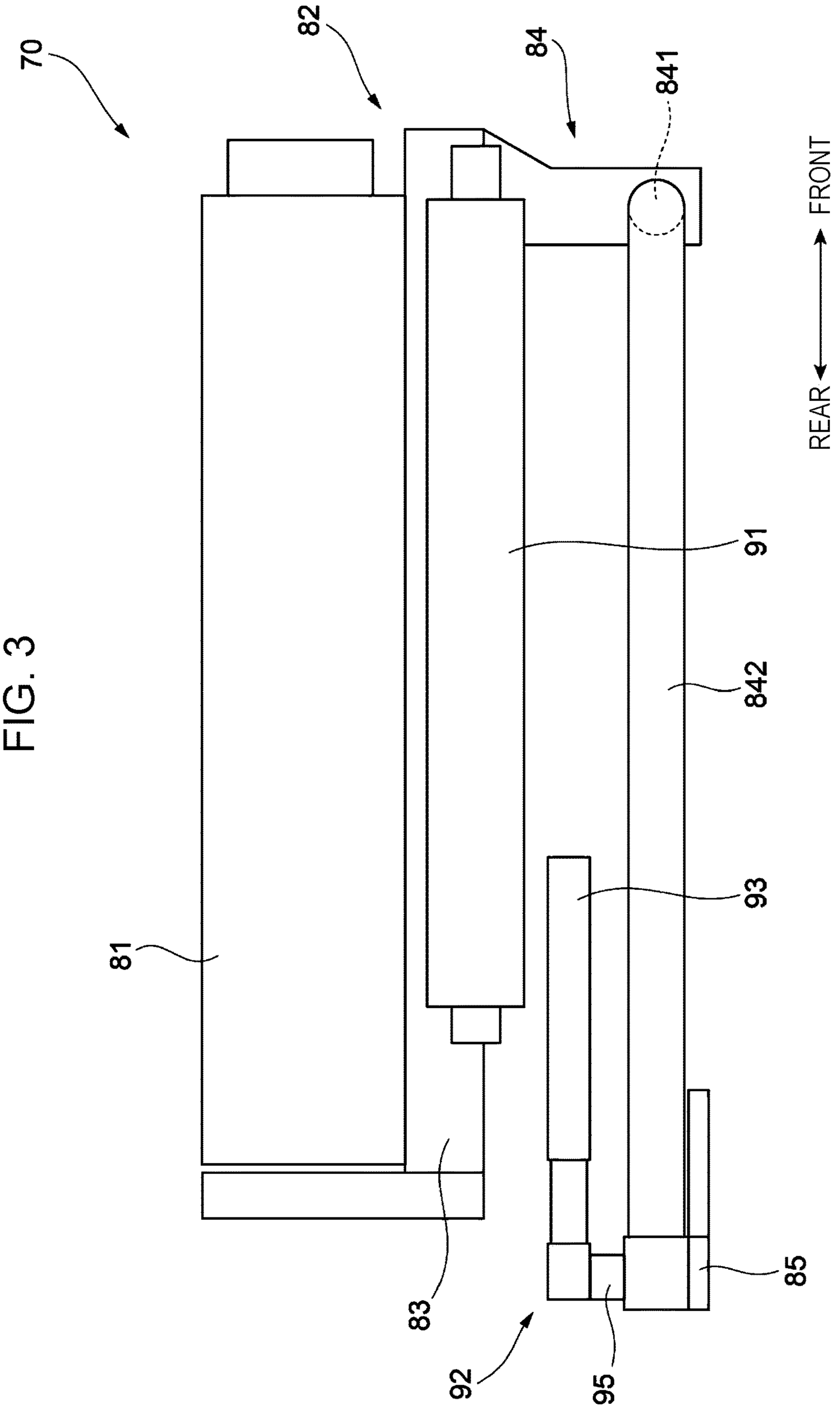
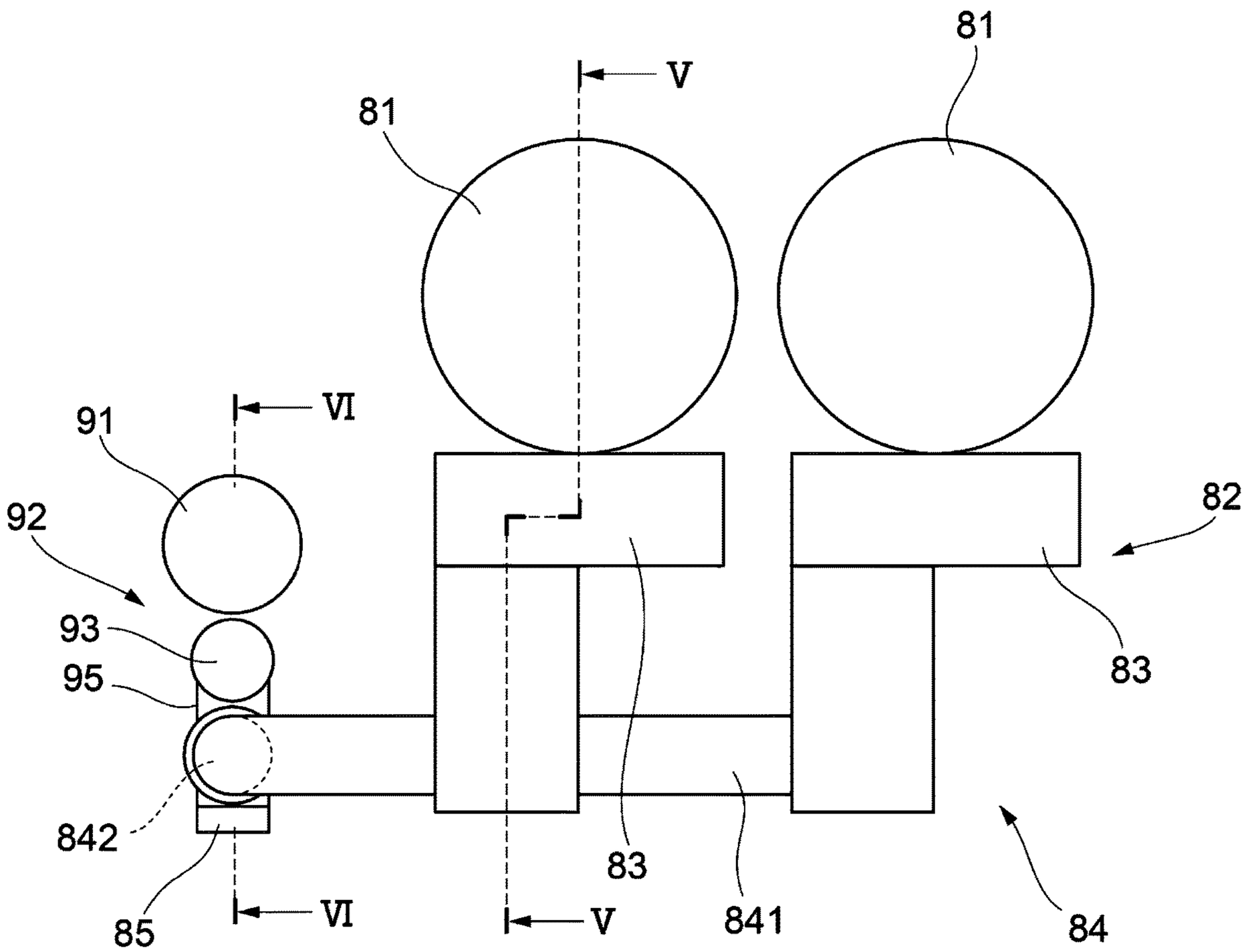


FIG. 3

FIG. 4



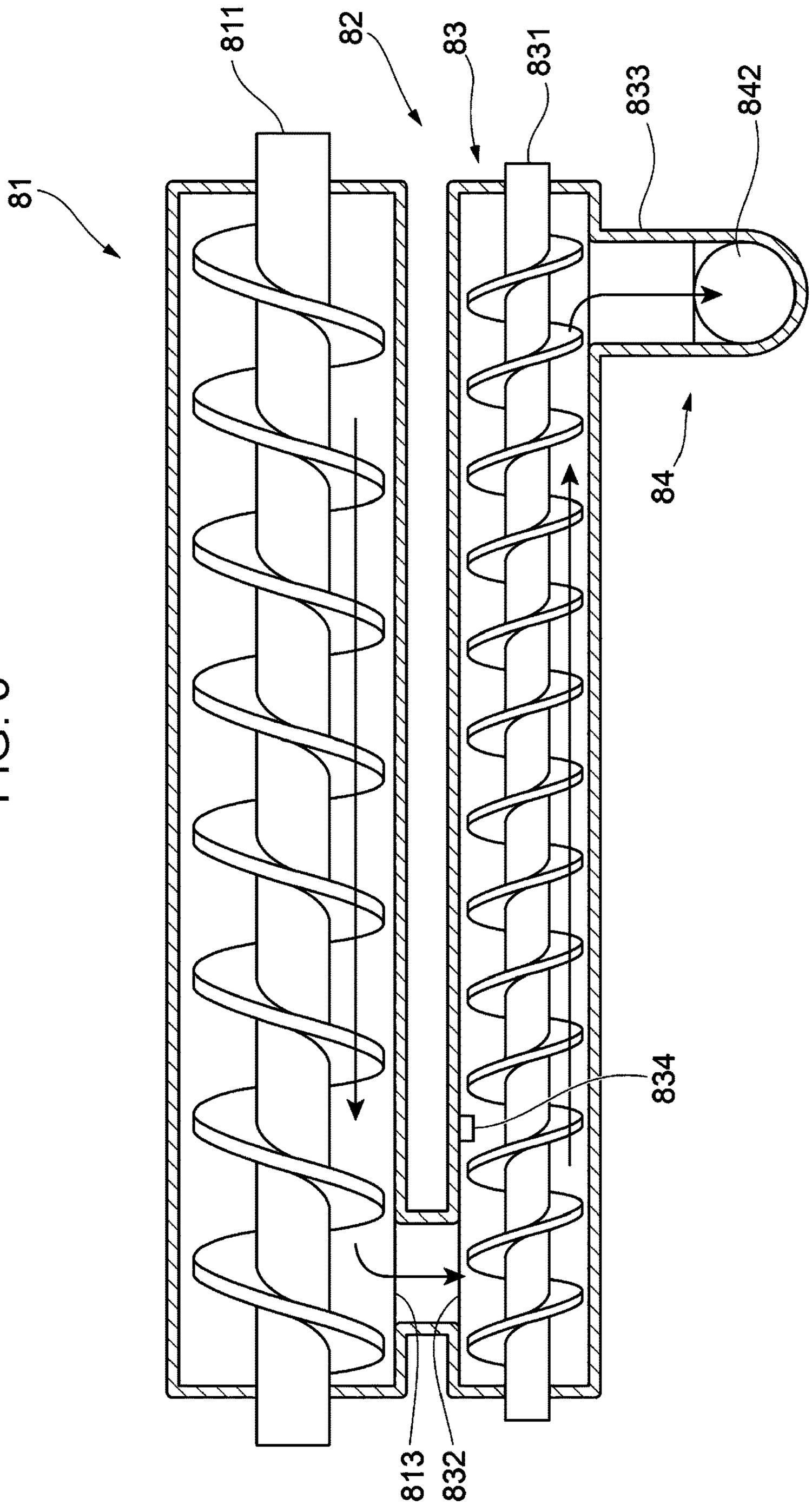


FIG. 5

FIG. 6

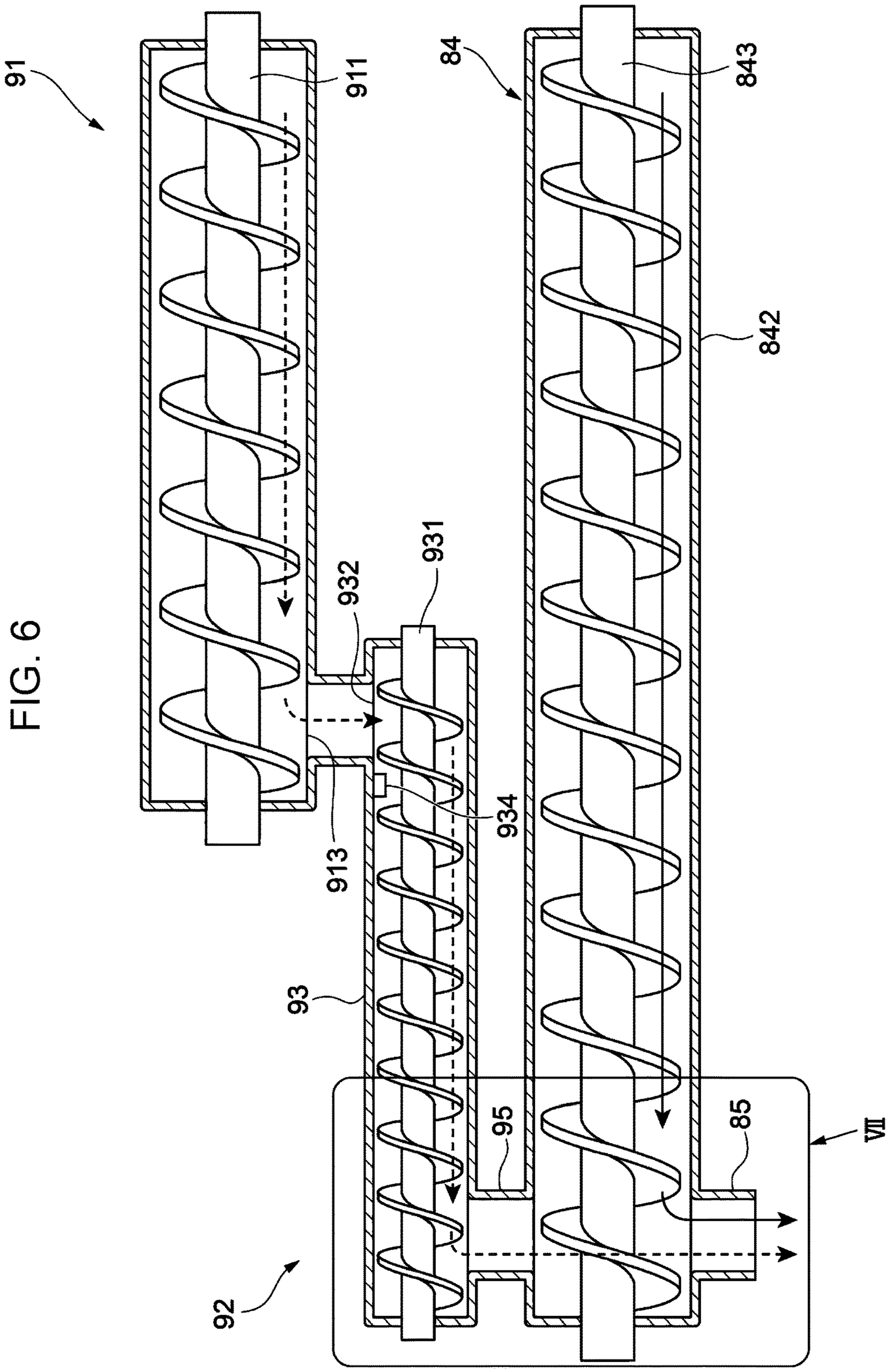
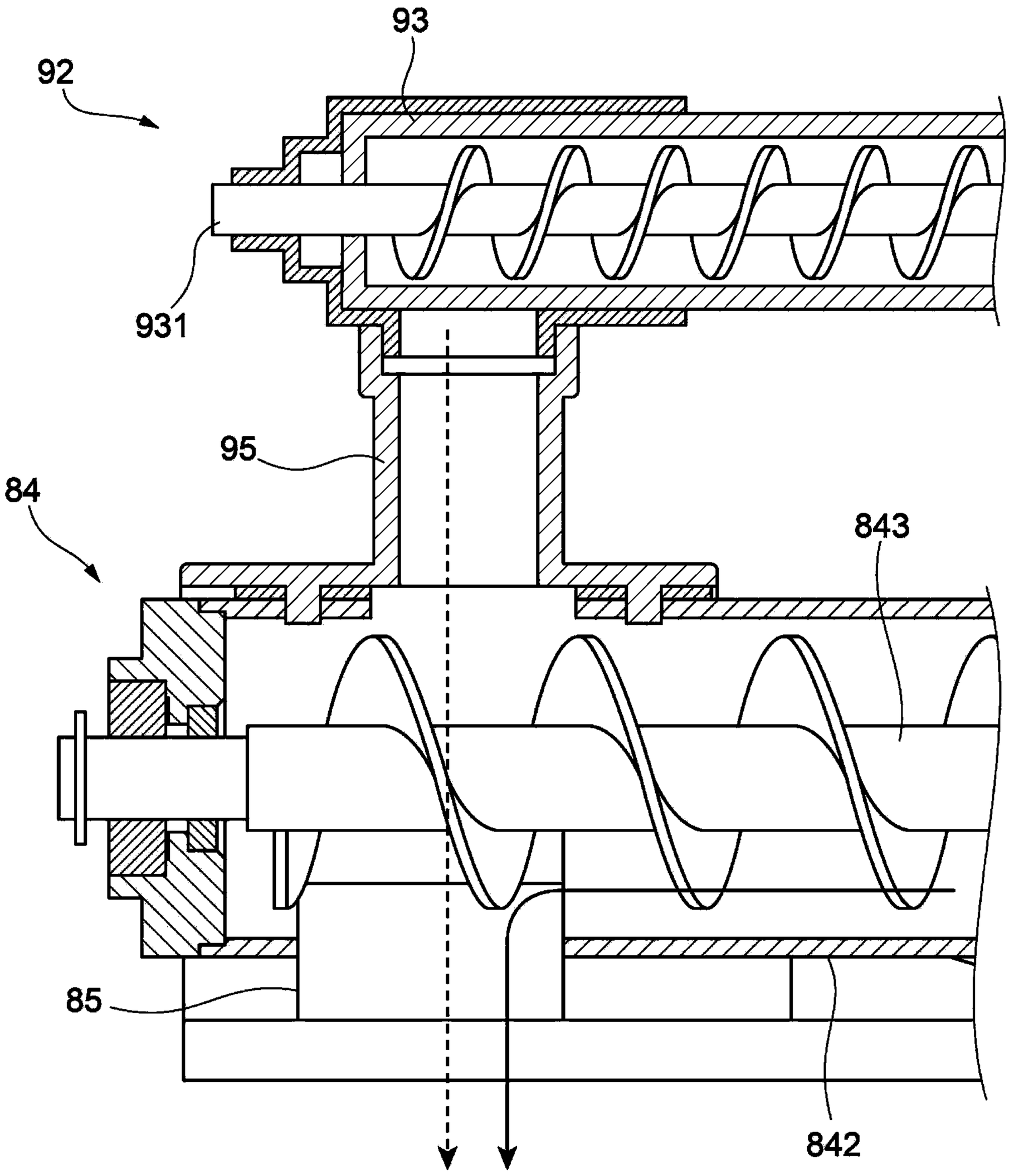


FIG. 7



DEVELOPER SUPPLY DEVICE AND IMAGE FORMING APPARATUS

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is based on and claims priority under 35 USC 119 from Japanese Patent Application No. 2020-054231 filed Mar. 25, 2020.

BACKGROUND

(i) Technical Field

The present disclosure relates to a developer supply device and an image forming apparatus.

(ii) Related Art

Japanese Unexamined Patent Application Publication No. 2015-108843 discloses a developer container that includes a container body having a toner storage space and a carrier tank having a carrier storage space and that supplies toner and carrier to a developing device.

SUMMARY

Aspects of non-limiting embodiments of the present disclosure relate to reducing the total capacity of a carrier supply part for supplying carrier to a developing device and a toner supply part for supplying toner to the developing device, compared with a case where the carrier supply part and the toner supply part have the same capacity.

Aspects of certain non-limiting embodiments of the present disclosure address the above advantages and/or other advantages not described above. However, aspects of the non-limiting embodiments are not required to address the advantages described above, and aspects of the non-limiting embodiments of the present disclosure may not address advantages described above.

According to an aspect of the present disclosure, there is provided a developer supply device including: a toner storage part that can be attached to/removed from a body of the developer supply device and stores toner therein; a toner supply part that receives the toner from the toner storage part and supplies the toner to a developing device that develops an electrostatic latent image formed on an image carrier with developer containing the toner and carrier; a carrier storage part that can be attached to/removed from the body and stores the carrier therein; and a carrier supply part that receives the carrier from the carrier storage part and supplies the carrier to the developing device, the carrier supply part having a smaller capacity than the toner supply part.

BRIEF DESCRIPTION OF THE DRAWINGS

Exemplary embodiment of the present disclosure will be described in detail based on the following figures, wherein:

FIG. **1** schematically shows the structure of an image forming apparatus according to an exemplary embodiment;

FIG. **2** is a perspective view of a developer supply device according to the exemplary embodiment;

FIG. **3** shows the developer supply device as viewed in direction III in FIG. **2**;

FIG. **4** shows the developer supply device as viewed in direction IV in FIG. **2**;

FIG. **5** is a sectional view taken along line V-V in FIG. **4**;

FIG. **6** is a sectional view taken along line VI-VI in FIG. **4**; and

FIG. **7** is an enlarged view of area VII in FIG. **6**.

DETAILED DESCRIPTION

An exemplary embodiment of the present disclosure will be described below with reference to the attached drawings.

Overall Configuration of Image Forming Apparatus

FIG. **1** schematically shows the structure of an image forming apparatus **100** according to an exemplary embodiment.

The image forming apparatus **100** in FIG. **1** is a so-called tandem image forming apparatus using an intermediate transfer method. The image forming apparatus **100** includes a plurality of image forming units **1**Y, **1**M, **1**C, and **1**K that form color-component toner images using an electrophotographic system.

The image forming apparatus **100** includes: first transfer parts **10** that successively first-transfer the color component toner images formed by the image forming units **1**Y, **1**M, **1**C, and **1**K to an intermediate transfer belt **15** in a superimposed manner; and a second transfer part **20** that second-transfers the superimposed toner image on the intermediate transfer belt **15** to a sheet **50**.

The image forming apparatus **100** also includes: a fixing device **60** that fixes the second-transferred toner image to the sheet **50**; a controller **40** that includes a program-controlled central processing unit (CPU) and controls the respective components of the image forming apparatus **100**; and a user interface (UI) **45** that includes a display panel and the like and via which information is received from/displayed to a user.

The image forming apparatus **100** also includes developer supply devices **70**Y, **70**M, **70**C, and **70**K for supplying developer to developing devices **14** (described below) of the image forming units **1**Y, **1**M, **1**C, and **1**K. Although detailed descriptions will be given below, the developer supply devices **70**Y, **70**M, **70**C, and **70**K supply, to the developing devices **14** of the image forming units **1**Y, **1**M, **1**C, and **1**K, carrier having magnetic properties and color toners corresponding to the image forming units **1**Y, **1**M, **1**C, and **1**K, the carrier and the toner serving as developer. In this example, the carrier has a positive charging polarity, and the toner has a negative charging polarity.

The developer supply devices **70**Y, **70**M, **70**C, and **70**K have the same structure except for the colors of the toner. Hereinbelow, the developer supply devices **70**Y, **70**M, **70**C, and **70**K will be simply referred to as the "developer supply devices **70**" when they do not need to be distinguished from one another.

The image forming units **1**Y, **1**M, **1**C, and **1**K, serving as a part of an image forming section, each include the following electrophotographic devices: a charger **12** provided near a photoconductor drum **11**, which serves as an example of an image carrier and is rotated in an arrow A direction, to charge the photoconductor drum **11**; and a laser exposure device **13** that forms an electrostatic latent image on the photoconductor drum **11**. The exposure beam emitted from the laser exposure device **13** is denoted by reference sign Bm in FIG. **1**.

The image forming units **1**Y, **1**M, **1**C, and **1**K also each include: a developing device **14** that stores the developer containing the carrier and the toner and develops the electrostatic latent image on the photoconductor drum **11** with the toner into a visible image; a first transfer roller **16** that transfers the color toner image on the photoconductor drum

11 to the intermediate transfer belt 15 at a first transfer part 10; and a drum cleaner 17 that removes residual toner on the photoconductor drum 11.

The intermediate transfer belt 15 is moved in a cycle at a predetermined speed in the direction of arrow B in FIG. 1 by a driving roller 31 driven by a motor (not shown). The first transfer part 10 includes the first transfer roller 16 opposed to the photoconductor drum 11 with the intermediate transfer belt 15 therebetween. The toner images on the photoconductor drums 11 are successively and electrostatically attracted to the intermediate transfer belt 15, and thus, a superimposed toner image is formed on the intermediate transfer belt 15.

The second transfer part 20 includes a second transfer roller 22, which is disposed on the toner-image carrying side of the intermediate transfer belt 15, and a backup roller 25. The second transfer roller 22 is disposed so as to push the backup roller 25 with the intermediate transfer belt 15 therebetween. The second transfer roller 22 is grounded so that a second transfer bias is formed between the backup roller 25 and the second transfer roller 22, and the toner image is second-transferred to the sheet 50 transported to the second transfer part 20. A belt cleaner 27 removes residual toner on the intermediate transfer belt 15.

The image forming units 1Y, 1M, 1C, and 1K can be attached to/removed from the body of the image forming apparatus 100 in the front-rear direction of the image forming apparatus 100. More specifically, the image forming units 1Y, 1M, 1C, and 1K are removed from the image forming apparatus 100 by being pulled toward the front side of the image forming apparatus 100.

The basic image forming processing of the image forming apparatus 100 will be described.

In the image forming apparatus 100, image data is outputted from an image reading device or the like (not shown), is converted into color-material gradation data of four colors, namely, Y, M, C, and K, through image processing by an image processing device (not shown), and is output to the laser exposure devices 13.

The laser exposure devices 13 irradiate the photoconductor drums 11 of the image forming units 1Y, 1M, 1C, and 1K with exposure beams Bm emitted from, for example, semiconductor laser sources according to inputted color-material gradation data. The surfaces of the photoconductor drums 11 charged by the chargers 12 are irradiated with the exposure light by the laser exposure devices 13, and as a result, electrostatic latent images are formed. After the toner images are formed on the photoconductor drums 11 by the developing devices 14, the toner images are transferred to the intermediate transfer belt 15 at the first transfer parts 10, where the photoconductor drums 11 and the intermediate transfer belt 15 are in contact with each other.

After the toner images are first-transferred to the surface of the intermediate transfer belt 15 in a superimposed manner, the toner image is transported to the second transfer part 20 by the intermediate transfer belt 15. At the second transfer part 20, the second transfer roller 22 is pressed against the backup roller 25 with the intermediate transfer belt 15 therebetween. At this time, a sheet 50 transported from a first sheet storage part 53 or a second sheet storage part 54 by transport rollers 52 and the like is nipped between the intermediate transfer belt 15 and the second transfer roller 22.

The unfixed toner image on the intermediate transfer belt 15 is electrostatically transferred to the sheet 50 at the second transfer part 20. Then, the sheet 50 to which the toner image has been electrostatically transferred is separated from the intermediate transfer belt 15 and is transported to a transport belt 55 provided downstream of the second transfer roller 22 in the sheet transport direction. The transport belt 55 transports the sheet 50 to the fixing device 60.

The toner image on the sheet 50 transported to the fixing device 60 is subjected to heat and pressure by the fixing device 60 and is fixed to the sheet 50. Then, the sheet 50 with the image fixed thereon is discharged from the image forming apparatus 100.

The toner remaining on the photoconductor drums 11 after the first transfer is removed by the drum cleaners 17, and the toner remaining on the intermediate transfer belt 15 after the second transfer is removed by the belt cleaner 27.

The image forming apparatus 100 repeats this image forming processing by the number of cycles corresponding to the number of sheets to be printed.

Configuration of Developer Supply Device

Next, the developer supply device 70 according to this exemplary embodiment will be described.

FIG. 2 is a perspective view of the developer supply device 70 according to this exemplary embodiment. The developer supply device 70 is attached to the image forming apparatus 100 (see FIG. 1) such that the lower right part thereof in FIG. 2 is located on the front side of the image forming apparatus 100 and the upper left part thereof in FIG. 2 is located on the rear side of the image forming apparatus 100.

FIG. 3 shows the developer supply device 70 as viewed in direction III in FIG. 2, and FIG. 4 shows the developer supply device 70 as viewed in direction IV (i.e., from the front side) in FIG. 2. FIG. 5 is a sectional view taken along line V-V in FIG. 4, FIG. 6 is a sectional view taken along line VI-VI in FIG. 4, and FIG. 7 is an enlarged view of area VII in FIG. 6.

The developer supply device 70 according to this exemplary embodiment includes two toner cartridges 81 storing toner therein, and a toner dispenser 82 that receives the toner from the toner cartridges 81 and supplies the toner to the developing device 14 (see FIG. 1). The two toner cartridges 81 have the same structure. The toner cartridges 81 are an example of a toner storage part.

The developer supply device 70 also includes a carrier cartridge 91 storing carrier therein, and a carrier dispenser 92 that receives the carrier from the carrier cartridge 91 and supplies the carrier to the developing device 14. In this example, the developer supply device 70 has one carrier cartridge 91. The carrier cartridge 91 is an example of a carrier storage part.

The toner cartridges 81 have a cylindrical shape with the central axis extending in the front-rear direction of the developer supply device 70. The toner cartridges 81 can be attached to/removed from the body of the developer supply device 70 in the front-rear direction of the developer supply device 70. More specifically, the toner cartridges 81 are removed from the developer supply device 70 by being pulling toward the front side of the developer supply device 70, and are attached to the developer supply device 70 by being pushed into the developer supply device 70 toward the rear side.

The toner cartridges 81 each have, inside thereof, a toner stirring member 811 for stirring the toner. The toner stirring member 811 is rotationally driven by a driving motor (not shown) to transport the toner inside the toner cartridge 81 from the front side to the rear side while stirring. The toner transport direction in the toner cartridges 81 equals to the direction in which the toner cartridges 81 are attached to/removed from the developer supply device 70 (attach-

ment/removal direction). In this exemplary embodiment, what is meant by "the toner transport direction equals to the attachment/removal direction" is not necessarily be "the toner transport direction is parallel to the attachment/removal direction", but may be "the transport direction has at least a component in the attachment/removal direction".

The toner cartridges **81** have, in the circumferential surfaces thereof, toner discharge portions **813** through which the toner transported by the toner stirring members **811** is discharged into toner reserve tanks **83** (described below) of the toner dispenser **82**. In this example, the toner discharge portions **813** are provided on the rear side of the toner cartridges **81**, in the lower circumferential portions facing the toner reserve tanks **83**. The toner is discharged downward toward the toner reserve tanks **83** through the toner discharge portions **813**.

The toner dispenser **82** includes two toner reserve tanks **83** storing the toner received from the corresponding toner cartridges **81**, a toner transport part **84** that receives the toner from the toner reserve tanks **83** and transports the toner to the developing device **14**, and a toner loading part **85** via which the toner transported through the toner transport part **84** is supplied to the developing device **14**. The two toner reserve tanks **83** have the same structure. The toner reserve tanks **83** are an example of a toner supply part.

The toner reserve tanks **83** have a long box shape extending in the front-rear direction of the developer supply device **70**. The toner reserve tanks **83** are located vertically below the toner cartridges **81**.

The toner reserve tanks **83** have, inside thereof, toner transport members **831** that transport the toner while stirring. The toner transport members **831** are rotationally driven by driving motors (not shown) to transport the toner inside the toner reserve tanks **83** from the rear side to the front side while stirring. In this exemplary embodiment, the toner transport direction in the toner reserve tanks **83** is opposite to the toner transport direction in the toner cartridges **81**. The toner transport direction in the toner reserve tanks **83** equals to the attachment/removal direction in which the toner cartridges **81** are attached to/removed from the developer supply device **70**.

The toner transport members **831** are, for example, screw augers including rotary shafts extending in the front-rear direction of the toner reserve tanks **83** and spiral blades formed around the rotary shafts.

Furthermore, toner detecting parts **834** are provided in the toner reserve tanks **83**. The toner detecting parts **834** detect whether there is toner in the toner reserve tanks **83**. The toner detecting parts **834** are provided at positions closer to toner receiving parts **832** than to toner discharge portions **833**. The toner detecting parts **834** may be any known sensors, such as magnetic sensors, piezoelectric sensors, photoelectronic sensors, or the like.

The toner reserve tanks **83** have, in the circumferential surfaces thereof, the toner receiving parts **832**, from which the toner discharged from the toner discharge portions **813** in the toner cartridges **81** is received, and the toner discharge portions **833**, from which the toner transported by the toner transport members **831** is discharged to a toner combining part **841** (described below) of the toner transport part **84**.

In this example, the toner receiving parts **832** are provided so as to face the toner discharge portions **813** in the toner cartridges **81**. More specifically, the toner receiving parts **832** are provided on the rear side of the toner reserve tanks **83**, in the upper circumferential portions facing the toner discharge portions **813** in the toner cartridges **81**.

The toner discharge portions **833** are provided on the front side of the toner reserve tanks **83**, in the lower circumferential portions facing the toner combining part **841** of the toner transport part **84**. The toner is discharged downward toward the toner combining part **841** through the toner discharge portions **833**.

The toner transport part **84** includes: the toner combining part **841** where the toner discharged from the toner discharge portions **833** in the toner reserve tanks **83** is combined; and a toner transport path **842** through which the toner having passed through the toner combining part **841** is transported to the toner loading part **85**.

The toner transport path **842** has a cylindrical shape extending in the front-rear direction of the developer supply device **70**. The toner transport path **842** has, inside thereof, a toner transport member **843** that transports the toner while stirring. The toner transport member **843** is rotationally driven by a driving motor (not shown) to transport the toner inside the toner transport path **842** from the front side to the rear side while stirring. More specifically, the toner transport direction in the toner transport part **84** equals to the attachment/removal direction in which the toner cartridges **81** are attached to/removed from the developer supply device **70**.

The toner transported through the toner transport path **842** is supplied to the developing device **14** (see FIG. **1**) via the toner loading part **85**. In this exemplary embodiment, the toner loading part **85** is located vertically above the developing device **14**. At the toner loading part **85**, the toner is allowed to fall downward by the gravity and is supplied to the developing device **14**.

The carrier cartridge **91** has a cylindrical shape with the central axis extending in the front-rear direction of the developer supply device **70**. The carrier cartridge **91** can be attached to/removed from the body of the developer supply device **70** in the front-rear direction of the developer supply device **70**. More specifically, the carrier cartridge **91** is removed from the developer supply device **70** by being pulled toward the front side of the developer supply device **70**, and is attached to the developer supply device **70** by being pushed into the developer supply device **70** toward the rear side.

Although a detailed description will be given below, the length of the carrier cartridge **91** according to this exemplary embodiment in the attachment/removal direction with respect to the developer supply device **70** (in this example, the length in the front-rear direction) is smaller than the length of the toner cartridges **81** in the attachment/removal direction with respect to the developer supply device **70**. The rear end of the carrier cartridge **91** is located closer to the front side of the developer supply device **70** than the rear ends of the toner cartridges **81** are.

The carrier cartridge **91** has, inside thereof, a carrier stirring member **911** for stirring the carrier. The carrier stirring member **911** is rotationally driven by a driving motor (not shown) to transport the carrier inside the carrier cartridge **91** from the front side to the rear side while stirring. More specifically, the carrier transport direction in the carrier cartridge **91** equals to the attachment/removal direction of the carrier cartridge **91** with respect to the developer supply device **70**.

The carrier cartridge **91** has, in the circumferential surface thereof, a carrier discharge portion **913** through which the carrier transported by the carrier stirring member **911** is discharged into a carrier reserve tank **93** of the carrier dispenser **92**. In this example, the carrier discharge portion **913** is provided on the rear side of the carrier cartridge **91**, in the lower circumferential portion facing the carrier

reserve tank **93**. The carrier is discharged downward toward the carrier reserve tank **93** through the carrier discharge portion **913**.

The carrier dispenser **92** includes: the carrier reserve tank **93**, serving as a carrier supply part, that stores the carrier received from the carrier cartridge **91**; and a carrier loading part **95** via which the carrier stored in the carrier reserve tank **93** is supplied to the developing device **14**.

The carrier reserve tank **93** has a long cylindrical shape extending in the front-rear direction of the developer supply device **70**. The carrier reserve tank **93** is located vertically below the carrier cartridge **91**.

Although a detailed description will be given below, the capacity of the carrier reserve tank **93** according to this exemplary embodiment is smaller than the capacity of a toner reserve tank **83**. The sectional area of the carrier reserve tank **93** in a direction perpendicular to the attachment/removal direction of the carrier cartridge **91** with respect to the developer supply device **70** (front-rear direction) is smaller than that of the toner reserve tank **83**. In this exemplary embodiment, by making the sectional area of the carrier reserve tank **93** smaller than the sectional area of the toner reserve tank **83**, the space for the carrier reserve tank **93** in the developer supply device **70** is reduced.

The carrier reserve tank **93** has, inside thereof, a carrier transport member **931** that transports the carrier while stirring. The carrier transport member **931** is rotationally driven by a driving motor (not shown) to transport the carrier inside the carrier reserve tank **93** from the front side to the rear side of the carrier reserve tank **93** while stirring. In this exemplary embodiment, the carrier transport direction in the carrier reserve tank **93** is equal to the carrier transport direction in the carrier cartridge **91**. More specifically, the carrier transport direction in the carrier cartridge **91** equals to the attachment/removal direction of the carrier cartridge **91** with respect to the developer supply device **70**.

The carrier transport member **931** is, for example, a screw auger including a rotary shaft extending in the front-rear direction of the carrier reserve tank **93** and a spiral blade formed around the rotary shaft.

Furthermore, a carrier detecting part **934** is provided in the carrier reserve tank **93**. The carrier detecting part **934** detects if there is carrier in the carrier reserve tank **93**. The carrier detecting part **934** is provided at a position closer to a carrier receiving part **932** than to the carrier loading part **95**. The carrier detecting part **934** may be any known sensor, such as a magnetic sensor, a piezoelectric sensor, a photoelectronic sensor, or the like.

The amount of carrier transported by the carrier transport member **931** in the carrier reserve tank **93** is smaller than the amount of toner transported by the toner transport member **831** in the toner reserve tank **83**. This is achieved by, for example, making the diameter of the screw auger constituting the carrier transport member **931** smaller than that of the toner transport member **831**, or making the blade pitch of the screw auger constituting the carrier transport member **931** smaller than that of the toner transport member **831**.

The carrier reserve tank **93** has, in the circumferential surface thereof, the carrier receiving part **932** through which the carrier discharged from the carrier discharge portion **913** in the carrier cartridge **91** is received. The carrier receiving part **932** is provided so as to face the carrier discharge portion **913** in the carrier cartridge **91**. More specifically, the carrier receiving part **932** is provided on the front side of the carrier reserve tank **93**, in an upper circumferential portion facing the carrier discharge portion **913** in the carrier cartridge **91**.

The carrier stored in the carrier reserve tank **93** is supplied to the developing device **14** (see FIG. **1**) via the carrier loading part **95**. In this exemplary embodiment, the carrier loading part **95** is located vertically above the developing device **14**. More specifically, the carrier loading part **95** is located vertically above the toner loading part **85** of the toner dispenser **82**. At the carrier loading part **95**, the carrier is allowed to fall downward by the gravity and is supplied to the developing device **14**. More specifically, at the carrier loading part **95**, the carrier is supplied to the developing device **14** by dropping the carrier from vertically above the toner loading part **85**.

Operation of Developer Supply Device

Next, the operation of the developer supply device **70** will be described.

The developer supply device **70** supplies the toner and the carrier to the developing device **14** as the toner and the carrier in the developing device **14** decrease. The developing device **14** consumes the toner when forming a toner image on the photoconductor drum **11**. In addition, the developing device **14** discharges developer containing carrier whose charging property has decreased. Thus, the toner and the carrier in the developing device **14** decrease.

Typically, the amount by which the carrier in the developing device **14** decreases per unit time is smaller than the amount by which the toner in the developing device **14** decreases per unit time.

For example, when the toner density in the developing device **14** falls below a predetermined reference value, the developer supply device **70** supplies toner to the developing device **14**.

More specifically, in the developer supply device **70**, the toner stirring members **811** in the toner cartridges **81**, the toner transport members **831** in the toner reserve tanks **83**, and the toner transport member **843** in the toner transport path **842** are rotationally driven. As a result, in the respective toner cartridges **81**, the toner is transported from the front side to the rear side of the toner cartridges **81** by the toner stirring members **811** and flows in the toner reserve tanks **83** of the toner dispenser **82**. In the respective toner reserve tanks **83**, the toner is transported from the rear side to the front side of the toner reserve tanks **83** by the toner transport members **831** and flows in the toner transport part **84**. In the toner transport part **84**, the toner is transported from the front side to the rear side in the toner transport path **842** by the toner transport member **843** and flows in the toner loading part **85**. Then, the toner falls down from the toner loading part **85** into the developing device **14** and thus is supplied to the developing device **14**.

In the developer supply device **70**, when the amount of toner stored in a toner cartridge **81** falls below a predetermined reference value (for example, when the toner cartridge **81** become empty), the toner cartridge **81** is removed from the body of the developer supply device **70** to be replaced with a new toner cartridge **81**.

In the developer supply device **70** according to this exemplary embodiment, the toner reserve tank **83** of the toner dispenser **82** stores the toner received from the toner cartridge **81**. Hence, for example, even when the toner cartridge **81** is removed from the developer supply device **70** for replacement, the supply of toner to the developing device **14** is continued using the toner in the toner reserve tank **83**.

As described above, in the developing device **14**, the toner decreases by a greater amount than the carrier. Hence, in the developer supply device **70**, the amount of toner consumed in the toner cartridges **81** and the toner reserve tanks **83** due to the supply of toner to the developing device **14** is greater

than the amount of carrier consumed in the carrier cartridge **91** and the carrier reserve tank **93** due to the supply of carrier to the developing device **14**.

The developer supply device **70** according to this exemplary embodiment includes two toner cartridges **81** and two toner reserve tanks **83**. Hence, for example, even when one toner cartridge **81** or one toner reserve tank **83** becomes empty, the supply of toner to the developing device **14** is continued using the other toner cartridge **81** and the other toner reserve tank **83**.

In addition, as described above, in the developer supply device **70** according to this exemplary embodiment, the toner transport direction in the toner cartridges **81** and the toner transport direction in the toner reserve tanks **83** are opposite to each other. This makes it possible to increase the capacities of the toner cartridges **81** and the toner reserve tanks **83**, while avoiding an increase in size of the developer supply device **70**, compared with, for example, a case where the toner transport direction in the toner cartridges **81** and the toner transport direction in the toner reserve tanks **83** are equal. As a result, the frequency of replacing the toner cartridges **81** is reduced, and stopping of supply of toner stored in the reserve tanks **83** to the developing device **14** is avoided.

When a toner reserve tank **83** has become empty before the corresponding toner cartridge **81** is replaced with a new one, there is a time lag between when the new toner cartridge **81** is attached and when the toner in the attached toner cartridge **81** is supplied to the developing device **14** via the toner reserve tank **83**. To counter this, when the new toner cartridge **81** is attached, a toner transport operation is performed in the toner cartridge **81** and in the toner reserve tank **83** until the toner detecting part **834** detects the toner. Desirably, this toner transport operation is performed before the image forming apparatus **100** receives a print instruction from a user. Because the toner detecting part **834** is provided at a position closer to the toner receiving part **832** than to the toner discharge portion **833**, the toner detecting part **834** can accurately detect whether the toner cartridge **81** is empty.

When the amount of carrier in the developing device **14** falls below a predetermined reference value, the developer supply device **70** supplies the carrier to the developing device **14**.

More specifically, in the developer supply device **70**, the carrier stirring member **911** in the carrier cartridge **91** and the carrier transport member **931** in the carrier reserve tank **93** are rotationally driven. As a result, in the carrier cartridge **91**, the carrier is transported from the front side to the rear side of the carrier cartridge **91** by the carrier stirring member **911** and flows into the carrier reserve tank **93** of the carrier dispenser **92**. In the carrier reserve tank **93**, the carrier is transported from the front side to the rear side of the carrier reserve tank **93** by the carrier transport member **931** and flows into the carrier loading part **95**. Then, the carrier falls down from the carrier loading part **95** into the developing device **14** and thus is supplied to the developing device **14**.

In the developer supply device **70**, when the mount of carrier stored in the carrier cartridge **91** falls below a predetermined reference value (for example, when the carrier cartridge **91** becomes empty), the carrier cartridge **91** is removed from the developer supply device **70** to be replaced with a new carrier cartridge **91**.

In this exemplary embodiment, the carrier reserve tank **93** of the carrier dispenser **92** stores the carrier received from the carrier cartridge **91**. Hence, for example, even when the carrier cartridge **91** is removed from the developer supply device **70** for replacement, the supply of carrier to the developing device **14** is continued using the carrier stored in the carrier reserve tank **93**.

When the carrier reserve tank **93** has become empty before the carrier cartridge **91** is replaced with a new one, there is a time lag between when the new carrier cartridge **91** is attached and when the carrier in the attached carrier cartridge **91** is supplied to the developing device **14** via the carrier reserve tank **93**. To counter this, when the new carrier cartridge **91** is attached, a carrier transport operation is performed in the carrier cartridge **91** and in the carrier reserve tank **93** until the carrier detecting part **934** detects the carrier. Desirably, this carrier transport operation is performed before the image forming apparatus **100** receives a print instruction from the user. Because the carrier detecting part **934** is provided at a position closer to the carrier receiving part **932** than to the carrier loading part **95**, the carrier detecting part **934** can accurately detect whether the carrier cartridge **91** is empty.

In the developer supply device **70** according to this exemplary embodiment, the capacity of the carrier reserve tank **93** is smaller than the capacity of a toner reserve tank **83**.

As described above, in the developer supply device **70**, the amount of carrier consumed in the carrier reserve tank **93** due to the supply of carrier to the developing device **14** is smaller than the amount of toner consumed in the toner reserve tank **83** due to the supply of toner to the developing device **14**.

Hence, in the developer supply device **70** according to this exemplary embodiment, even though the capacity of the carrier reserve tank **93** is smaller than the capacity of the toner reserve tank **83**, a problem such as stopping of supply of the carrier to the developing device **14** is unlikely to occur.

In the developer supply device **70**, by making the capacity of the carrier reserve tank **93** smaller than the capacity of the toner reserve tank **83**, the overall volume of the carrier dispenser **92** can be reduced. As a result, the developer supply device **70** can be made compact.

In this exemplary embodiment, the length of the carrier reserve tank **93** in the attachment/removal direction of the toner cartridges **81** or the carrier cartridge **91** with respect to the developer supply device **70** is smaller than that of the toner reserve tanks **83**. This reduces the distance over which the carrier is transported in the carrier reserve tank **93** and the overall volume of the carrier dispenser **92**, compared with, for example, a case where the length of the carrier reserve tank **93** in the attachment/removal direction is equal to or larger than that of the toner reserve tanks **83**.

Furthermore, in this exemplary embodiment, the amount of carrier transported by the carrier transport member **931** in the carrier reserve tank **93** is smaller than the amount of toner transported by the toner transport members **831** in the toner reserve tanks **83**.

As described above, because the amount by which the carrier is supplied to the developing device **14** is smaller than the amount by which the toner is supplied to the developing device **14**, even though the amount of carrier transported by the carrier transport member **931** in the carrier reserve tank **93** is smaller than the amount of toner transported by the toner transport member **831** in the toner reserve tank **83**, a problem such as shortage of supply of carrier to the developing device **14** is unlikely to occur. In addition, by making the amount of carrier transported by the carrier transport member **931** in the carrier reserve tank **93** smaller than the amount of toner transported by the toner

transport member **831** in the toner reserve tank **83**, the carrier reserve tank **93** can easily be made compact.

Furthermore, in the developer supply device **70** according to this exemplary embodiment, as described above, the carrier transport direction in the carrier cartridge **91** and the carrier transport direction in the carrier reserve tank **93** are equal. This reduces the distance over which the carrier is transported in the carrier reserve tank **93**, compared with, for example, a case where the carrier transport direction in the carrier cartridge **91** and the carrier transport direction in the carrier reserve tank **93** are opposite to each other.

Furthermore, in the developer supply device **70** according to this exemplary embodiment, the length of the carrier cartridge **91** in the attachment/removal direction with respect to the developer supply device **70** is smaller than the length of the toner cartridges **81** in the attachment/removal direction with respect to the developer supply device **70**. The rear end of the carrier cartridge **91** is located closer to the front side of the developer supply device **70** than the rear ends of the toner cartridges **81** are.

Thus, the carrier dispenser **92** can be disposed in, for example, the area resulting from the difference between the length of the carrier cartridge **91** and the length of the toner cartridges **81** (i.e., behind the carrier cartridge **91**), and thus, the developer supply device **70** can be made compact.

In general, carrier has a greater specific gravity than toner. Hence, by making the length of the carrier cartridge **91**, which stores carrier having a greater specific gravity, in the attachment/removal direction smaller than the length of the toner cartridges **81**, which store toner having a smaller specific gravity, in the attachment/removal direction, the distance over which the user moves the carrier cartridge **91** in the attachment/removal direction when attaching/removing the carrier cartridge **91** can be made smaller than the distance over which the user moves the toner cartridges **81** in the attachment/removal direction when attaching/removing the toner cartridges **81**.

In the developer supply device **70** according to this exemplary embodiment, the carrier cartridge **91** is located vertically below the toner cartridges **81**. More specifically, the part of the carrier cartridge **91** located at the bottom in the vertical direction (hereinbelow, the lowermost part) is located vertically below the lowermost parts of the toner cartridges **81**. More desirably, the central axis or the part of the carrier cartridge **91** located at the top in the vertical direction (the uppermost part) is located vertically below the central axes or the uppermost parts of the toner cartridges **81**.

Because the carrier cartridge **91**, which stores carrier having a greater specific gravity, is located vertically below the toner cartridges **81**, which store toner having a smaller specific gravity, the user can attach/remove the carrier cartridge **91** to/from the developer supply device **70** at a position vertically below the position where the toner cartridges **81** are attached/removed.

Furthermore, in the developer supply device **70** according to this exemplary embodiment, the carrier is supplied to the developing device **14** from the carrier loading part **95** by being dropped from vertically above the toner loading part **85**.

By supplying the carrier having a greater specific gravity from vertically above the toner having a smaller specific gravity, the toner is pushed by the carrier dropped from vertically thereabove at the toner loading part **85** and is easily guided to the developing device **14**. Thus, clogging of toner at the toner loading part **85** is suppressed. In addition, mixing of the toner and the carrier is facilitated, reducing toner density nonuniformity in the developing device **14**.

Although the toner is directly supplied from the toner loading part **85** to the developing device **14**, and the carrier is directly supplied from the carrier loading part **95** to the developing device **14** in this exemplary embodiment, other structures are also possible.

For example, the toner loading part **85** and the carrier loading part **95** may supply the toner and the carrier to a transport path (not shown) along which the toner and the carrier are transported to the developing device **14**, so that the toner and the carrier are supplied to the developing device **14** via the transport path. In this case, for example, it is desirable that the toner is supplied to the transport path from the toner loading part **85**, and subsequently, the carrier is supplied to the transport path from the carrier loading part **95**, from vertically above the toner being transported.

Although the exemplary embodiment of the present disclosure has been described above, the present disclosure is not limited to the above-described exemplary embodiment as long as the purpose of the present disclosure is not impaired, and may be appropriately modified.

In this exemplary embodiment, the toner cartridges **81** are removed from the developer supply device **70** by being pulled out toward the front side of the developer supply device **70** and are attached to the developer supply device **70** by being pushed into the developer supply device **70** toward the rear side. However, the toner cartridges **81** may be removed from the developer supply device **70** by being pulled out toward the rear side of the developer supply device **70** and may be attached to the developer supply device **70** by being pushed into the developer supply device **70** toward the front side. The carrier cartridge **91** is removed from the developer supply device **70** by being pulled out toward the front side of the developer supply device **70** and is attached to the developer supply device **70** by being pushed into the developer supply device **70** toward the rear side. However, the carrier cartridge **91** may be removed from the developer supply device **70** by being pulled out toward the rear side of the developer supply device **70** and may be attached to the developer supply device **70** by being pushed into the developer supply device **70** toward the front side. In this case, when the image forming units **1**Y, **1**M, **1**C, and **1**K and the toner cartridges **81** and the carrier cartridge **91** are attached/removed at the same time, such attachment/removal can be simultaneously performed on the front side and the rear side of the image forming apparatus **100**.

In this exemplary embodiment, the toner cartridges **81** have, inside thereof, the toner stirring members **811** for stirring the toner. Instead, the toner may be transported by providing spiral projections on the inner circumferential surfaces of containers constituting the toner cartridges **81** and by rotationally driving the containers with driving motors (not shown). In this exemplary embodiment, the carrier cartridge **91** has, inside thereof, the carrier stirring member **911** for stirring the carrier. Instead, the carrier may be transported by providing a spiral projection on the inner circumferential surface of a container constituting the carrier cartridge **91** and by rotationally driving the container with a driving motor (not shown).

In this exemplary embodiment, the toner detecting parts **834** are provided at positions closer to the toner receiving parts **832** than to the toner discharge portions **833**.

Instead, the toner detecting parts **834** may be provided at positions closer to the toner discharge portions **833** than to the toner receiving parts **832**. In this case, the toner can be more easily supplied to positions near the toner discharge

portions **833** of the toner reserve tanks **83**. The carrier detecting part **934** is provided at a position closer to the carrier receiving part **932** than to the carrier loading part **95**. Instead, the carrier detecting part **934** may be provided at a position closer to the carrier loading part **95** than to the carrier receiving part **932**. In this case, the carrier can be more easily supplied to a position near the carrier loading part **95** of the carrier reserve tank **93**.

The foregoing description of the exemplary embodiment of the present disclosure has been provided for the purposes of illustration and description. It is not intended to be exhaustive or to limit the disclosure to the precise forms disclosed. Obviously, many modifications and variations will be apparent to practitioners skilled in the art. The embodiment was chosen and described in order to best explain the principles of the disclosure and its practical applications, thereby enabling others skilled in the art to understand the disclosure for various embodiments and with the various modifications as are suited to the particular use contemplated. It is intended that the scope of the disclosure be defined by the following claims and their equivalents.

What is claimed is:

1. A developer supply device comprising:

a toner storage part that can be attached to/removed from a body of the developer supply device and stores toner therein;

a toner supply part that receives the toner from the toner storage part and supplies the toner to a developing device that develops an electrostatic latent image formed on an image carrier with developer containing the toner and carrier;

a carrier storage part that can be attached to/removed from the body and stores the carrier therein; and

a carrier supply part that receives the carrier from the carrier storage part and supplies the carrier to the developing device, the carrier supply part having a smaller capacity than the toner supply part.

2. The developer supply device according to claim **1**, wherein

the toner supply part supplies the toner to the developing device after transporting the toner in an attachment/removal direction in which the toner storage part is attached/removed,

the carrier supply part supplies the carrier to the developing device after transporting the carrier in the attachment/removal direction, and

the length of the carrier supply part in the attachment/removal direction is smaller than the length of the toner supply part in the attachment/removal direction.

3. The developer supply device according to claim **2**, wherein the toner supply part transports the toner in a direction opposite to a toner transport direction in the toner storage part.

4. The developer supply device according to claim **2**, wherein the carrier supply part transports the carrier in the same direction as a carrier transport direction in the carrier storage part.

5. The developer supply device according to claim **3**, wherein the carrier supply part transports the carrier in the same direction as a carrier transport direction in the carrier storage part.

6. The developer supply device according to claim **1**, wherein

the toner supply part supplies the toner to the developing device after transporting the toner in an attachment/removal direction in which the toner storage part is attached/removed,

the carrier supply part supplies the carrier to the developing device after transporting the carrier in the attachment/removal direction, and

a sectional area of the carrier supply part in a direction perpendicular to the attachment/removal direction is smaller than a sectional area of the toner supply part in the direction perpendicular to the attachment/removal direction.

7. The developer supply device according to claim **6**, wherein an amount of carrier transported by a carrier transport member in the carrier supply part is smaller than an amount of toner transported by a toner transport member in the toner supply part.

8. The developer supply device according to claim **1**, wherein

the toner supply part supplies the toner to the developing device by dropping the toner, and

the carrier supply part supplies the carrier to the developing device by dropping the carrier from vertically above the toner supply part.

9. The developer supply device according to claim **1**, wherein a length of the carrier storage part in an attachment/removal direction with respect to the body is smaller than the length of the toner storage part in the attachment/removal direction.

10. The developer supply device according to claim **1**, wherein a lowermost part of the carrier storage part in a vertical direction is located vertically below a lowermost part of the toner storage part in the vertical direction.

11. The developer supply device according to claim **10**, wherein a central axis or an uppermost part, in the vertical direction, of the carrier storage part is located vertically below a central axis or the uppermost part, in the vertical direction, of the toner storage part.

12. An image forming apparatus comprising:

an image carrier that carries an image;

a developing device that develops an electrostatic latent image formed on the image carrier with developer containing toner and carrier;

a toner storage part that stores the toner and that can be attached to/removed from a body of a developer supply device;

a toner supply part that receives the toner from the toner storage part and supplies the toner to the developing device;

a carrier storage part that can be attached to/removed from the body and stores the carrier therein; and

a carrier supply part that receives the carrier from the carrier storage part and supplies the carrier to the developing device, the carrier supply part having a smaller capacity than the toner supply part.

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